Yield and nutritive value of binary legume-grass mixtures under grazing

Bélanger G.[1], Tremblay G.F.[1], Dos Passos Bernardes A.[1], Papadopoulos Y.[2], Fillmore S.[2], Lajeunesse J.[1] and Duynisveld J.[2]
[1]Agriculture and Agri-Food Canada, Soils and Crops Research and Development Centre, Québec, QC, G1V 2J3, Canada; [2]Agriculture and Agri-Food Canada, Atlantic Food and Horticulture Research Centre, Kentville, NS, B4N 1J5, Canada; gilles.belanger@agr.gc.ca

Abstract

Legume-grass mixtures generally provide more consistent forage yield than monocultures. We studied 18 binary mixtures of one legume and one grass species for dry matter (DM) yield, neutral detergent fibre (NDF) concentration and *in vitro* digestibility (NDFD), and estimated milk production per hectare. Cocksfoot (*Dactylis glomerata* L.), Kentucky bluegrass (*Poa pratensis* L.), meadow bromegrass (*Bromus biebersteinii* Roemer & J.A. Schultes), meadow fescue (*Festuca elatior* L.), tall fescue [*Schedonorus phoenix* (Scop.) Holub], and timothy (*Phleum pratense* L.) were seeded with birdsfoot trefoil (*Lotus corniculatus* L.), lucerne (*Medicago sativa* L.) or white clover (*Trifolium repens* L.). Frequent clipping at two sites, simulating grazing, and cattle grazing at one site were imposed on the 18 binary mixtures in this 3-year study conducted in eastern Canada. Legume and grass species significantly affected seasonal herbage DM yield, NDF concentration, and NDFD of the mixtures averaged over three production years. Birdsfoot trefoil in mixtures with meadow bromegrass or timothy resulted in the largest estimated milk production per hectare under frequent clipping, whereas white clover with meadow bromegrass or tall fescue provided the best results under cattle grazing. Frequent clipping and cattle grazing affected differently the performance of the mixtures, primarily for the legume component. Meadow bromegrass performed very well with the three legume species and under both frequent clipping and cattle grazing.

Keywords: frequent clipping, grazing, digestibility, simple forage mixtures

Introduction

Legume-grass mixtures generally provide more consistent forage yield across a wide range of environments than grass or legume monocultures (Sleugh *et al.*, 2000; Sturludóttir *et al.*, 2013). Forage legumes also fix atmospheric N thereby reducing the need for N fertilization. Cocksfoot, Kentucky bluegrass, meadow fescue, tall fescue, timothy, and meadow bromegrass are forage grass species that are well adapted to the cool seasons of eastern Canada. Lucerne, white clover, and birdsfoot trefoil are perennial legume species recommended in eastern Canada but their performance and nutritive value in mixtures with grasses and under grazing are not well documented. Little information exists in eastern Canada on what species to use in mixtures and on the nutritive value of those mixtures. Our objective was to identify binary legume-grass mixtures with high forage yield and nutritive value under both frequent clipping and cattle grazing.

Materials and methods

The experiment was conducted in eastern Canada with frequent clipping to a 7-cm sward height with a self-propelled flail forage harvester at two sites (Lévis and Normandin, QC) to simulate grazing or with cattle grazing at Nappan (NS). Plots were clipped or grazed when timothy reached about 25 cm in height. Binary legume-grass mixtures (18) of one of six grass species (cocksfoot, Kentucky bluegrass, meadow bromegrass, meadow fescue, tall fescue, and timothy) were seeded in 2010 with birdsfoot trefoil, lucerne or white clover. Binary mixtures were replicated three times in a split-plot layout, with legume species as main plots set out as a Latin square and grass species randomized to the subplots. Herbage yield, neutral detergent fibre (NDF) concentration, and *in vitro* digestibility (NDFD) were measured at

each clipping or grazing event, and potential milk production per hectare was estimated with MILK2006 (Undersander *et al.*, 2006) for three production years (2011, 2012, and 2013). MILK2006 calculates the total digestible nutrient concentration and milk produced per Mg of alfalfa-grass forages based on NDFD and NRC (2001) equations using an Excel spreadsheet. Data were assessed across treatments by analyses of variance (ANOVA) using the GENSTAT 14 statistical software. Treatments and harvest methods (frequent clipping and cattle grazing) were considered fixed effects.

Results and discussion

Legume and grass species significantly ($P<0.01$) affected seasonal herbage DM yield, NDF concentration, and NDFD of the mixtures averaged over three production years (Table 1). The effect of the legume and grass species, however, varied with the harvest method as indicated by a significant ($P<0.01$) interaction of the legume and grass species with the harvest method for seasonal dry matter (DM) yield and NDF concentration. Among the 18 binary mixtures, seasonal DM yields ranged from 4.48 to 6.94 Mg ha^{-1} with frequent clipping and from 5.57 to 7.62 Mg ha^{-1} with cattle grazing. Significant variations in NDF concentrations (392-484 and 471-554 g kg^{-1} DM) and NDFD (693-756 and 599-718 g kg^{-1} NDF) were also observed among the 18 binary mixtures under frequent clipping and cattle grazing, respectively.

The estimated milk production per hectare integrates both the DM yield and nutritive value of the herbage. Birdsfoot trefoil-based mixtures (11.7 Mg ha^{-1}) generally resulted in greater estimated milk production than lucerne-based (9.4 Mg ha^{-1}) and white clover-based mixtures (8.8 Mg ha^{-1}) under frequent clipping, but in lower estimated milk production under cattle grazing (11.1 vs 12.1 and 12.4 Mg ha^{-1}, Figure 1). Timothy- and meadow bromegrass-based mixtures generally resulted in greater estimated milk production (10.5 and 11.0 Mg ha^{-1} under frequent clipping; 12.0 and 12.7 Mg ha^{-1} under cattle grazing) than the other grass species-based mixtures. These differences in estimated milk production are due more to differences in DM yield than to differences in nutritive value (Table 1). Overall, birdsfoot trefoil mixed with either meadow bromegrass or timothy resulted in the largest estimated milk production per hectare under frequent clipping, whereas white clover with meadow bromegrass or tall

Table 1. Main effects of legume and grass species on herbage seasonal dry matter (DM) yield, neutral detergent fibre (NDF) concentration, and *in vitro* NDF digestibility (NDFD) of the mixtures under frequent clipping and cattle grazing. Values are averages over three production years.

Mixtures	DM yield (Mg ha^{-1})		NDF (g kg^{-1} DM)		NDFD (g kg^{-1} NDF)	
	Frequent clipping	Cattle grazing	Frequent clipping	Cattle grazing	Frequent clipping	Cattle grazing
Legumes						
Birdsfoot trefoil	6.13	6.14	428	522	726	677
Lucerne	5.17	6.71	435	511	711	665
White clover	4.74	6.72	462	505	746	698
SEM[1]	1.21		7.1		11.6	
Grasses						
Meadow bromegrass	6.03	6.75	449	484	732	690
Timothy	5.39	6.36	402	508	729	697
Tall fescue	5.37	7.05	471	529	737	696
Kentucky bluegrass	5.22	6.81	430	529	696	619
Meadow fescue	5.08	6.20	445	525	744	704
Cocksfoot	4.99	5.97	454	502	728	675
SEM	1.22		8.0		11.8	

[1] SEM = standard error of the mean.

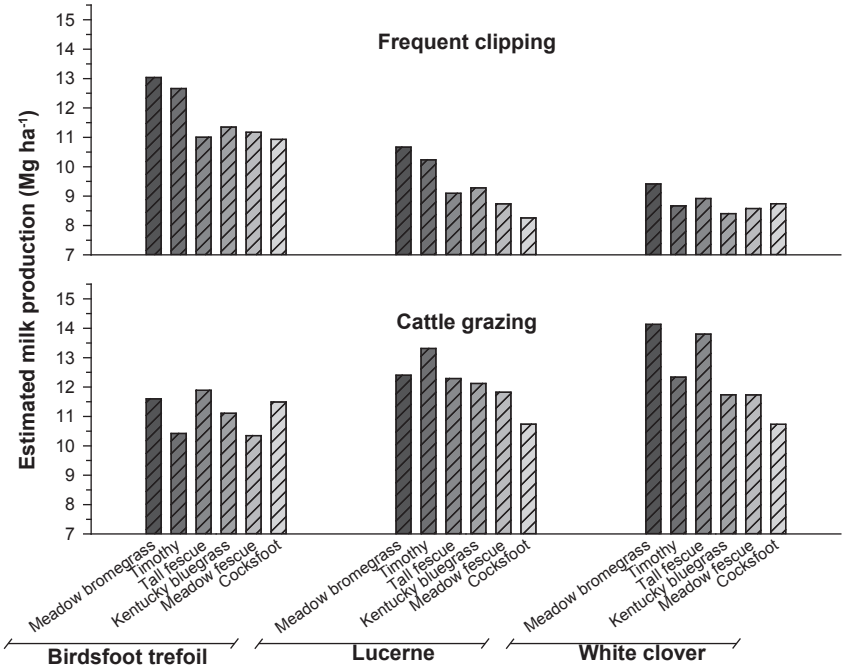

Figure 1. Estimated milk production per hectare for 18 binary grass-legume mixtures under frequent clipping and cattle grazing. Values are averages over three production years (standard error of the mean = 2.28 Mg ha^{-1}).

fescue provided the best results under cattle grazing. With cattle grazing, animal preference for birdsfoot trefoil might have reduced its DM yield and persistence over the three years of the study.

Conclusions

Frequent clipping and cattle grazing affected differently the performance of the mixtures, primarily for the legume component. Meadow bromegrass performed very well with the three legume species and under both frequent clipping and cattle grazing.

References

NRC (2001) *Nutrient requirement of dairy cattle*. 6th revised ed. National Academy of Sciences, Washington, DC, USA.

Sleugh B., Moore K.J., George J.R. and Brummer E.C. (2000) Binary legume-grass mixtures improve forage yield, quality, and seasonal distribution. *Agronomy Journal* 92, 24-29.

Sturludóttir E., Brophy C., Bélanger G., Gustavsson A.-M., Jørgensen M., Lunnan T. and Helgadóttir Á. (2013) Benefits of mixing grasses and legumes for herbage yield and nutritive value in northern Europe and Canada. *Grass and Forage Science* 69, 229-240.

Undersander D., Combs D., Shaver R. and Hoffman P. (2006) University of Wisconsin alfalfa/grass evaluation system – MILK 2006. UW Extension. Available at: http://www.uwex.edu/ces/dairynutrition/documents/milk2006alfalfa-grassprotected.xls.